A quasi-invariant for the vorticity equation on a rotating sphere is obtained by a minimization process.

The distribution of the weighting coefficient for the quasi-invariant has airfoil-shaped contours (Fig. 1, solid curves), with which the anisotropic energy transfer that favors zonally elongated structures can be explained.

Freely-evolving turbulence experiments confirm that the quasi-invariant is conserved well when the nonlinearity of the system is sufficiently weak.

When the quasi-invariant is conserved well, energy is transferred in the wavenumber space apparently along the airfoil-shaped contours of the weighting coefficient for the quasi-invariant (Fig. 1).